

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property
Organization
International Bureau



(43) International Publication Date
8 April 2004 (08.04.2004)

PCT

(10) International Publication Number
WO 2004/029538 A1

(51) International Patent Classification⁷: F41H 1/08, 5/04

(21) International Application Number:
PCT/IL2003/000782

(22) International Filing Date:
30 September 2003 (30.09.2003)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
152006 30 September 2002 (30.09.2002) IL

(81) Designated States (*national*): AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, YU, ZA, ZM, ZW.

(84) Designated States (*regional*): ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IT, LU, MC, NL, PT, RO, SE, SI, SK, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

(71) Applicant (*for all designated States except US*): RABIN-
TEX INDUSTRIES LTD. [IL/IL]; 28 Lechi Street, 51200
Bnei-Brak (IL).

(72) Inventor; and

(75) Inventor/Applicant (*for US only*): KAPAH, Yoav [IL/IL];
P.O.Box 389, 10600 Nahalal (IL).

(74) Agent: REINHOLD COHN AND PARTNERS; P.O.Box
4060, 61040 Tel Aviv (IL).

Published:

- with international search report
- before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: SHELL FOR BALLISTIC HELMET

(57) Abstract: A shell for ballistic helmet formed from a plurality of paraaramide fabric layers such as KEVLAR-KM2[®], and bonding resin. All fabric layers have areal density less than 200g/m², preferably part of them have areal density less than 160g/m². The number of paraaramide layers is greater than 28, preferably 38 and more. The bonding resin constitutes less than 12% of the shell weight. The shell has average thickness less than 6.5 mm and average areal density less than 7.5 Kg/m². A method for the production of such shells includes pressing and bonding the plurality of layers at pressure equal to or above 150Kg/cm², preferably above 300Kg/cm².

WO 2004/029538 A1

SHELL FOR BALLISTIC HELMET

FIELD OF THE INVENTION

This invention relates to shells for ballistic helmets, and more particularly to helmet shells made of paraaramide fabrics such as Kevlar®, protecting from bullets and fragments.

5 BACKGROUND OF THE INVENTION

A shell for ballistic helmet is supposed to stop incident shrapnel fragments or bullets, thereby protecting the head of the user. The aim of shell design and manufacture is to obtain a shell providing required ballistic protection at minimal weight. The weight of the shell is of great importance because the helmet user
10 carries it for long periods of time, and the lighter the helmet, the more it is convenient in use.

The ballistic protection of the helmet is normally tested by the so-called V50 test, 17 grain, according to known US and European standards. The test measures the velocity at which 50% of fragments pierce the helmet while 50% are retained.
15 An average areal density of the shell material is the weight of the shell divided by its area. The ratio between the level of ballistic protection and the areal density is the decisive parameter determining the helmet quality, and in general if it is higher, then the helmet is better. This ratio is called protection coefficient:

$$\text{Protection coefficient} = V50/\text{areal density}$$

20 An additional parameter is the thickness of the shell. The smaller the thickness, the less awkward is the helmet and more convenient it is in usage.

One of the most common technologies for production of ballistic helmet shells is pressure forming of the shells in a mold, from a stack of paraaramide

- 2 -

fabric blanks with bonding resin. The manufacturers are known to use up to 16-24 layers of fabric with 220 to 300 g/m² areal density, and bonding resin in about 14-20% of the total shell weight. The stack of blanks soaked with resin is pressed in a mold at about 30-40 Kg/cm² pressure at temperature suitable for the resin polymerization. The obtained shells have more than 8-9 Kg/m² areal density, 7.5-9 mm thickness, and the shell weight is not less than 0.850 Kg.

SUMMARY OF THE INVENTION

In accordance with the present invention, there is provided a shell for ballistic helmet formed from a plurality of paraaramide fabric layers and bonding resin. The fabric layers have areal density less than 200g/m², the shell has average thickness less than 6.5 mm and average areal density less than 7.5 Kg/m². Preferably, part of the fabric layers have areal density less than 160g/m², while the rest fabric layers have areal density between 200 and 160g/m². The number of paraaramide layers should be greater than 28, preferably not less than 33, more preferably 38 and more, at least part of the layers having areal density not exceeding 160g/m².

Preferably, the bonding resin constitutes less than 12% of the shell weight.

The present invention is based on a surprising discovery of the inventors that, if in a shell for a ballistic helmet formed from a plurality of paraaramide fabric layers and bonding resin, considerably greater number of layers is used than that known heretofore with a lower areal density (weight) of the layers than that typically used in the practice, the shell yields the required ballistic protection at lighter weight than conventional helmet shells, or better ballistic protection with the same shell weight. Another contributing factor is the usage of layers with different areal density.

According to another aspect of the present invention, there is provided a method for the production of shells for ballistic helmets from a plurality of layers as

- 3 -

described above, the method including pressing and bonding the plurality of layers at pressure equal to or above 150Kg/cm^2 , preferably above 300Kg/cm^2 .

The composition and method of production according to the present invention provide for lighter helmets with better ballistic protection qualities. For
5 example, a shell with less than 0.7 Kg weight and level of protection higher than $V50 = 2000\text{ ft/sec}$ can be manufactured.

DETAILED DESCRIPTION OF THE INVENTION

One example of the material used for the production of a shell according to
10 the present invention is a material made of 38-40 layers of KEVLAR®-KM2 and/or other paraaramide fabric having areal density respectively 155g/m^2 and 195g/m^2 and bound by bonding resin of about 10-12% of the shell weight. The KEVLAR®-KM2 fabric is used mainly in the external layers of the shell.

The above shell structure is manufactured by pressing the stack of blanks to
15 6 mm thickness using pressures of 150 to 300Kg/cm^2 .

A prototype ballistic helmet shell with the inventive structure, manufactured by the above method weights 0.7 Kg and provides for level of protection $V50 = 2000\text{ ft/sec}$. The area of the shell is about 0.1 m^2 . The average areal density
20 of the shell is $0.7/0.1 = 7\text{ Kg/m}^2$, and the protection coefficient is $2000/7 = 286$.

- 4 -

CLAIMS:

1. Shell for ballistic helmet formed from a plurality of paraaramide fabric layers and bonding resin, wherein said fabric layers have areal density equal or less than 200g/m², said shell has average thickness less than 6.5 mm and average areal
5 density less than 7.5 Kg/m².
2. Shell according to Claim 1, wherein at least one of said fabric layers has areal density less than 160g/m².
3. Shell according to Claim 1, wherein part of said fabric layers have areal density less than 160g/m² and the rest fabric layers have areal density between 200
10 and 160g/m².
4. Shell according to Claim 2, wherein part of said paraaramide fabric layers are KEVLAR-KM2®.
5. Shell according to Claim 1, wherein said bonding resin constitutes less than 12% of the shell weight.
- 15 6. Shell according to Claim 1, wherein said plurality of layers is greater than 28.
7. Shell according to Claim 6, wherein said plurality of layers is not less than 33.
8. Shell according to Claim 7, wherein said plurality of layers is not less than
20 38.
9. Shell for ballistic helmet formed from a plurality of paraaramide fabric layers and bonding resin, wherein said plurality of layers is greater than 28 and said shell has average thickness less than 6.5 mm.
10. Shell for ballistic helmet formed from a plurality of paraaramide fabric
25 layers and bonding resin, wherein said plurality of layers is not less than 38.
11. Shell for ballistic helmet formed from a plurality of paraaramide fabric layers and bonding resin, wherein said fabric layers have areal density less than 200g/m², and said plurality of layers is greater than 28.

– 5 –

12. Shell for ballistic helmet formed from a plurality of paraaramide fabric layers and bonding resin, wherein said plurality of layers is greater than 28 and said shell has average areal density less than 7.0 Kg/m².

13. Method for production of shell for ballistic helmet according to anyone of
5 the preceding claims, including pressing and bonding of said plurality of layers at pressure equal or above 150Kg/cm².

14. Method according to Claim 12, wherein said pressure is equal or above 300Kg/cm².

INTERNATIONAL SEARCH REPORT

onal Application No

/IL 03/00782

A. CLASSIFICATION OF SUBJECT MATTER
 IPC 7 F41H1/08 F41H5/04

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 F41H A42B A41D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 00 42246 A (DORLOFF LUMPE; FELS (DE); BAUMGART (DE)) 20 July 2000 (2000-07-20)	1-4,6-14
Y	page 1, line 7,11,22,23 page 2, line 25-30 page 3, line 15-29 page 4, line 11-14,23,24,27-32 page 5, line 9 -page 6, line 22	5
Y	US 6 012 178 A (SCHUSTER ET AL) 11 January 2000 (2000-01-11)	5
A	abstract column 1, line 8-11,19,20 column 2, line 8-11 column 3, line 19-24,34-36 column 4, line 20-43	1
	--- -/-	

☒ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

12 February 2004

Date of mailing of the international search report

19/02/2004

Name and mailing address of the ISA

European Patent Office, P.B. 5818 Patentlaan 2
 NL - 2280 HV Rijswijk
 Tel. (+31-70) 340-2040, Tx. 31 651 epo nl,
 Fax: (+31-70) 340-3016

Authorized officer

Menier, R

INTERNATIONAL SEARCH REPORT

onal Application No

/IL 03/00782

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT		
Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	EP 1 241 432 A (TEIJIN TWARON GMBH) 18 September 2002 (2002-09-18) column 1, line 3-8,23,44,45 column 3, line 1-14,35-57 column 4, line 8 -column 5, line 2 ---	1,4, 6-10,12
A	US 4 916 000 A (PREVORSEK ET AL) 10 April 1990 (1990-04-10) column 1, line 10,55-58 column 4, line 66,67 column 8, line 26-29,41 column 9, line 7-15 column 10, line 58-60 column 13, line 48-52 column 15, line 61,62 column 16, line 47 column 17, line 1-6 column 18, line 41-58 column 19, line 3-44 column 20, line 1-46 ---	1,4, 6-10,12
A	WO 02 43949 A (PARKER; EVERITT (US); MOHAMED (US); 3TEX INC) 6 June 2002 (2002-06-06) page 1 -----	

INTERNATIONAL SEARCH REPORT

information on patent family members

onal Application No

PCT/IL 03/00782

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
WO 0042246	A	20-07-2000	AT 252657 T	15-11-2003
			AU 758613 B2	27-03-2003
			AU 2108800 A	01-08-2000
			BR 0007545 A	09-10-2001
			CA 2359965 A1	20-07-2000
			CN 1121519 B	17-09-2003
			CZ 20012618 A3	17-04-2002
			DE 60006064 D1	27-11-2003
			WO 0042246 A1	20-07-2000
			EP 1144740 A1	17-10-2001
			HR 20010540 A1	31-12-2002
			JP 2002535157 T	22-10-2002
			NO 20013359 A	06-07-2001
			PL 348777 A1	17-06-2002
			TR 200102066 T2	21-11-2001
			US 6610618 B1	26-08-2003
US 6012178	A	11-01-2000	DE 19613583 A1	31-10-1996
			AT 198794 T	15-02-2001
			AU 5686096 A	30-10-1996
			CA 2217445 A1	17-10-1996
			CN 1181132 A , B	06-05-1998
			DE 59606345 D1	22-02-2001
			DK 820576 T3	29-01-2001
			WO 9632620 A1	17-10-1996
			EP 0820576 A1	28-01-1998
			ES 2153575 T3	01-03-2001
			IL 117791 A	05-04-1998
			JP 11503512 T	26-03-1999
			NO 974523 A	30-09-1997
EP 1241432	A	18-09-2002	EP 1241432 A1	18-09-2002
			CA 2433966 A1	26-09-2002
			CA 2439585 A1	26-09-2002
			WO 02075237 A1	26-09-2002
			WO 02075238 A1	26-09-2002
			EP 1370820 A1	17-12-2003
			EP 1370821 A1	17-12-2003
			NO 20034028 A	11-11-2003
			NO 20034047 A	12-09-2003
			TW 536617 B	11-06-2003
			TW 531494 B	11-05-2003
US 4916000	A	10-04-1990	DE 3851844 D1	17-11-1994
			DE 3851844 T2	16-02-1995
			EP 0397696 A1	22-11-1990
			HK 1007122 A1	01-04-1999
			JP 2823912 B2	11-11-1998
			JP 3502431 T	06-06-1991
			WO 8906190 A1	13-07-1989
			US 5160776 A	03-11-1992
WO 0243949	A	06-06-2002	AU 2702802 A	11-06-2002
			WO 0243949 A2	06-06-2002